EAGLE SENSORS
REPORT FROM THE WEST COAST

ALAN BLOOM, N1AL

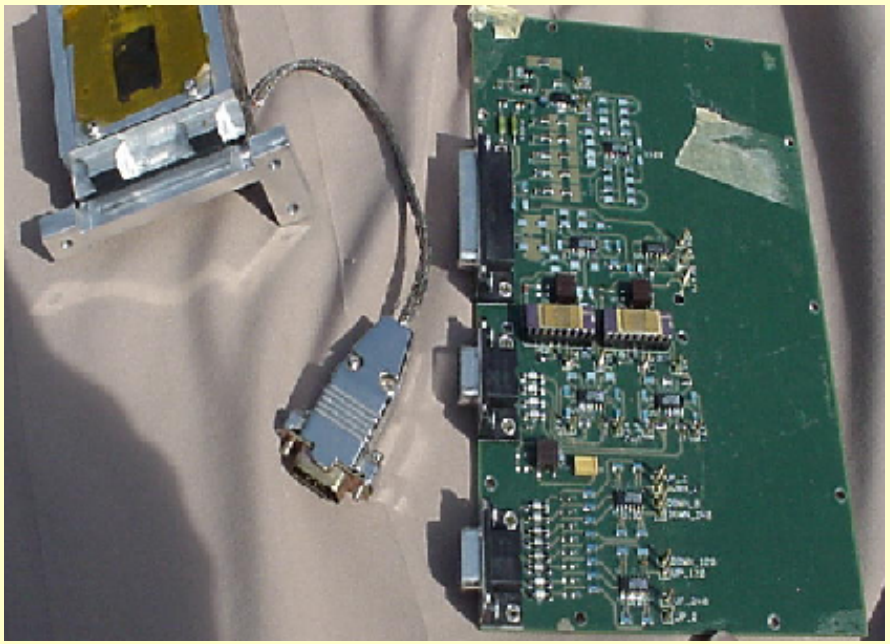
HERB SULLIVAN, K6QXB

HISTORY

- TUSON MEETING (1996) REQUEST BY BILL TYNAN W3XO.-- LOOKING FOR SOMEONE TO “TEST SOME SENSORS”
- SANTA ROSA JR. COLLEGE ELECTRONIC TECH STUDENTS VOLUNTEERED TO HELP WITH THE “TESTING” BY HERB, K6QXB
- AT HOME HAVE FIRST CONTACT WITH LOU McFADIN W5DID AND FIND OUT THAT WHAT IS REALLY WANTED IS A PACKAGE FOR P3D STARING MODE SENSORS. (BUYERS REMORSE)

HISTORY

- Needed to complete project for a May launch.
- Recruited a team with K2IYQ(SK) at the head
- Produced product (not perfect due to com-munications issues) in 120 days from idea to shipping.
- Electronics fully tested for temperature and accuracy.

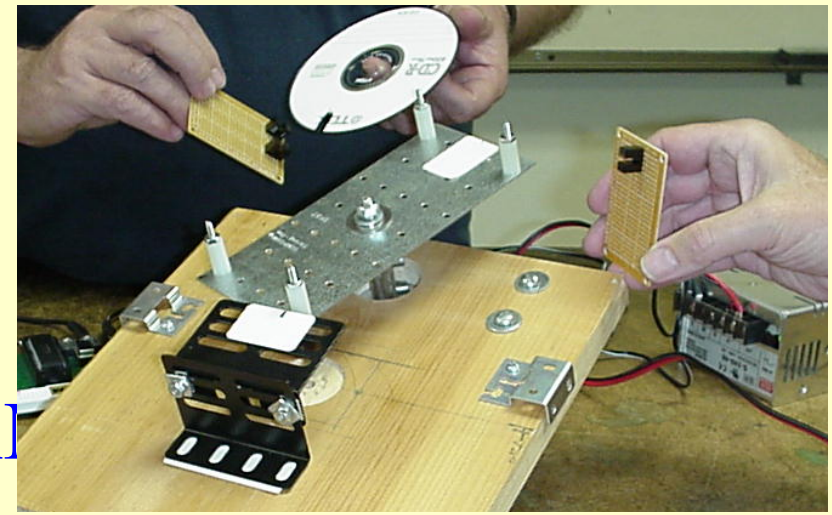


HISTORY

- Team also produced other pieces that were needed by the P3D team
- Sensors worked properly and successfully from initial turn on to the failure event
- In October 2002 a request was made to the team to take on the current sensor project
- The team was put back together and began work on the new sensor project.

HISTORY

- Two sensors types are under development.
  - Sun sensors:
    - Slit mode
    - Staring mode
- Earth sensor.
  - Slit mode
- Chassis boxes & CAD software to manufacture them.

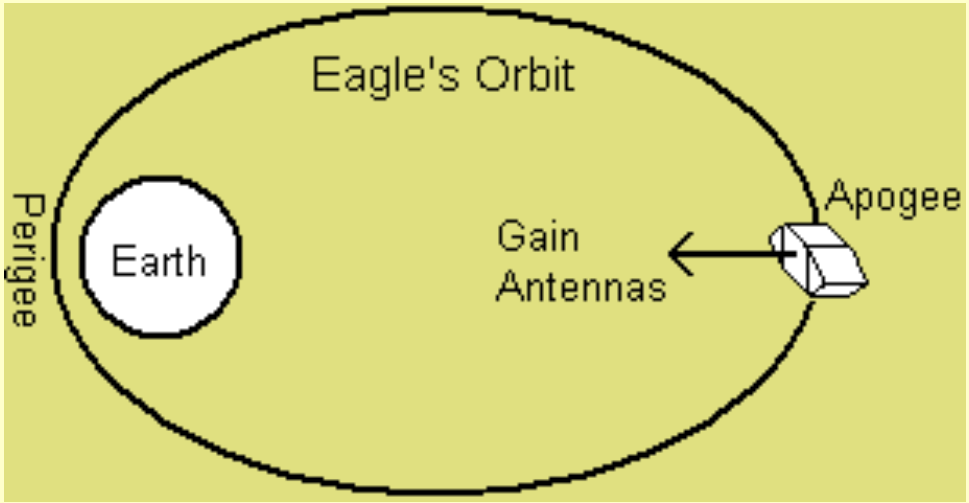


CURRENT SENSORS PROJECT

AL BLOOM, N1AL

THE PROBLEM

WHAT IS THE SATELLITE'S **POSITION** RELATIVE TO EARTH AND SUN?



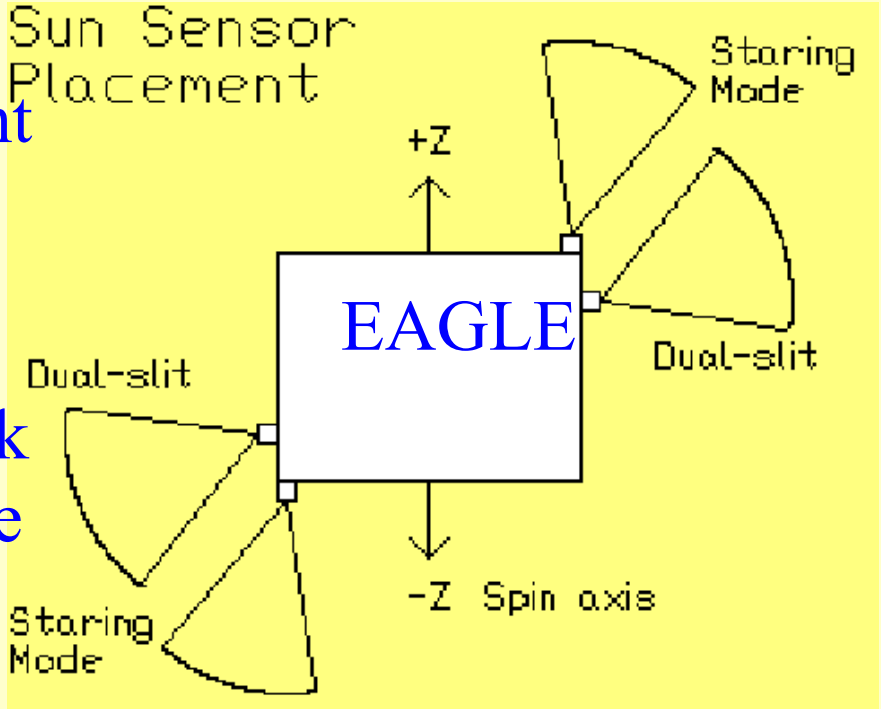
1. **Switch from gain to omni antennas near perigee**
2. **Spin axis must point to earth at apogee.**
3. **Sun and earth sensors determine Eagle's attitude and orbital position**

Two Types of Sun Sensor

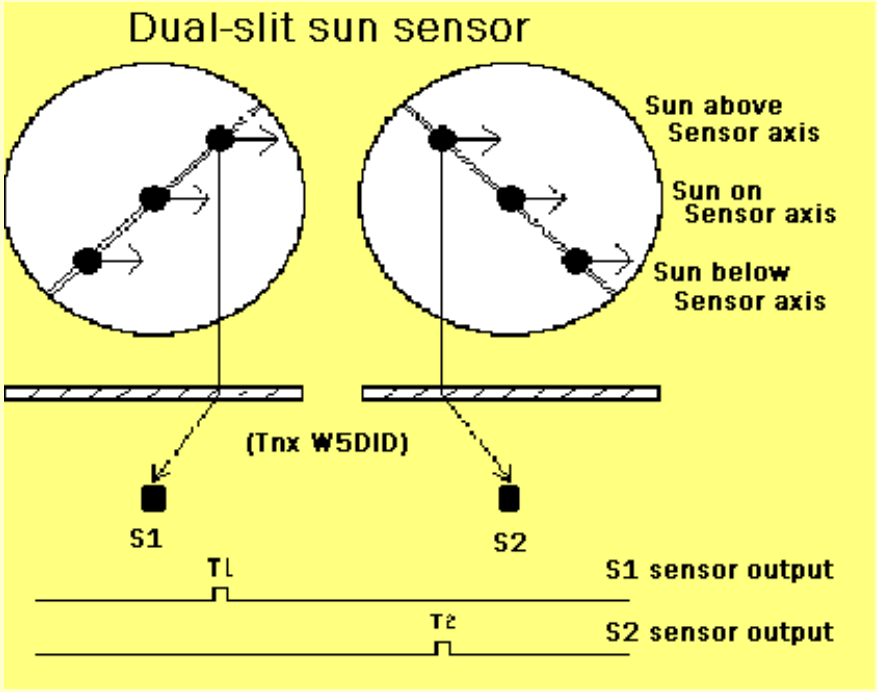
-Dual slit sensors that depend on satellite rotation. (they point sideways)

-Staring-mode sensors that work even when the sun appears to be motionless near the spin axis

-Overlapping fields of view cover all azimuth/elevation angles



DUAL SLIT OPERATION



1. Photo-detectors mounted in cavities behind angled slits

2. Relative timing of pulses depends on sun angle and spin rate.

3. Can determine spin rate, elevation and azimuth (with respect to a spin timing reference) by analyzing the time of each pulse)

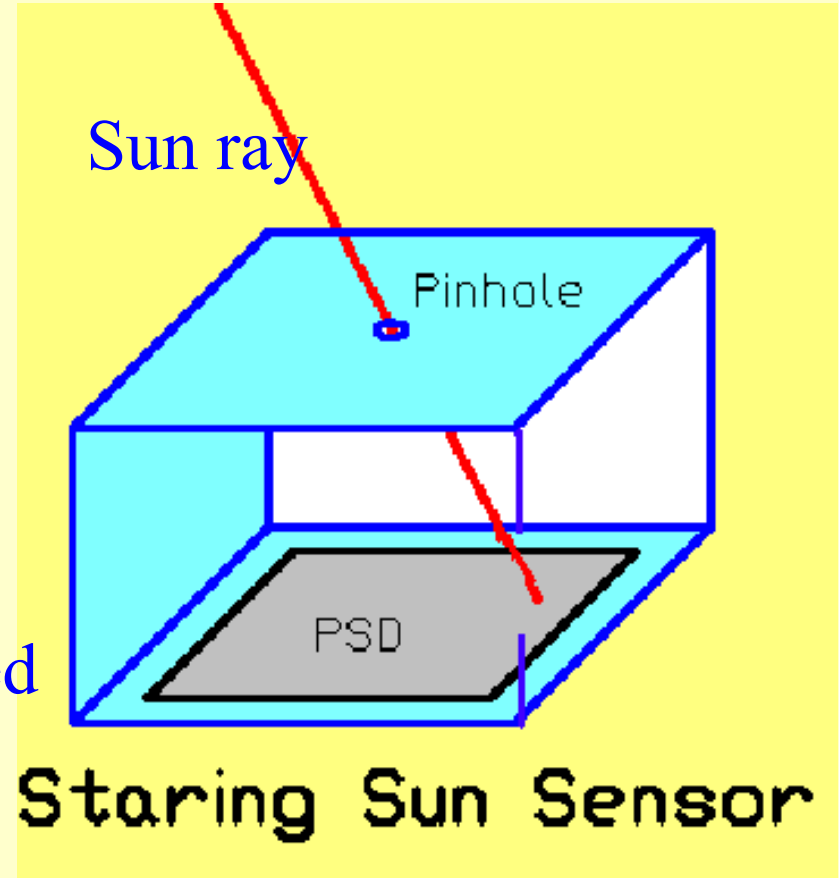
The Pin Hole Camera - Staring Sun Sensor

--Based on Hamamatsu Position Sensitive Detector (PSD)

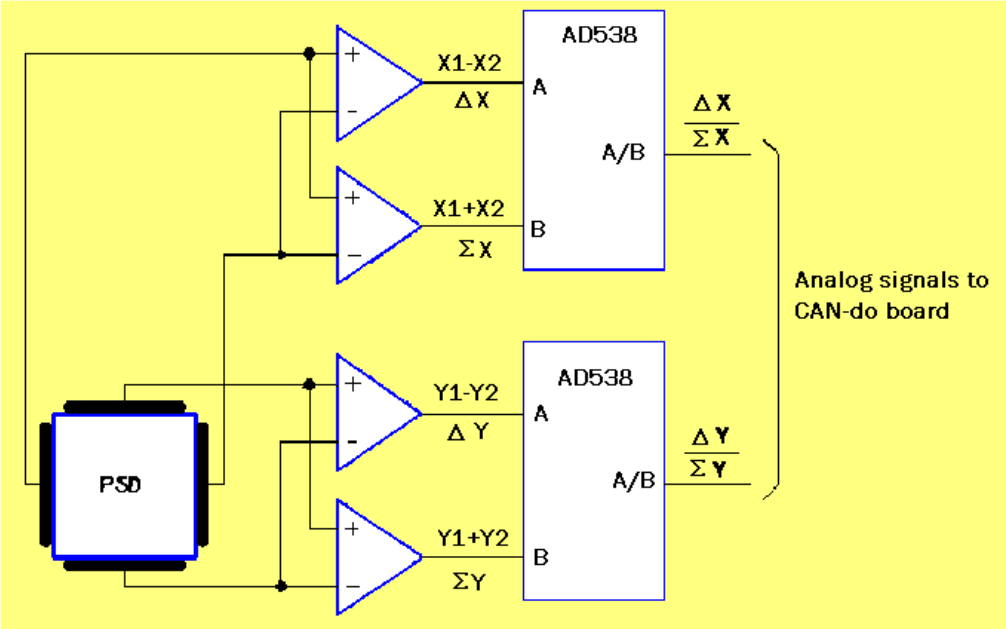
--Photodetector with transparent, resistive coating.

--Current is generated at the lighted spot

--Electrical contact at the 4 edges – most current flows to the closest contacts

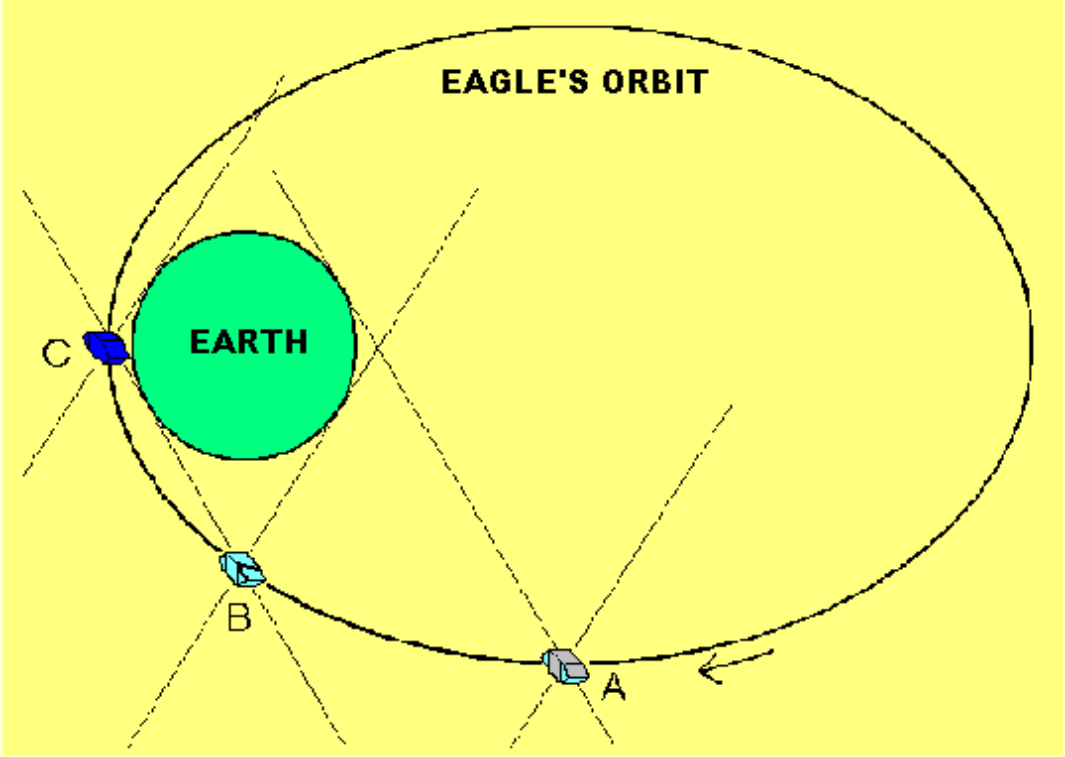


GENERATING LOCATION SIGNALS



1. Analog processing circuitry copied from AO-40 (P3D)
2. Current difference between opposite contacts is proportional to the position to position of the light spot.
3. Analog divider IC divides by total current to make output independent of light intensity, which maximizes the dynamic range of the A/D converter.

EARTH SENSORS



1.Purpose: determine satellite position near perigee

1.2 sensors pointed +/-60^{o} from spin axis

1.Should work over ½ of orbit

INFRA RED SLIT SENSOR DETECTOR

Horizon-Crossing Indicator

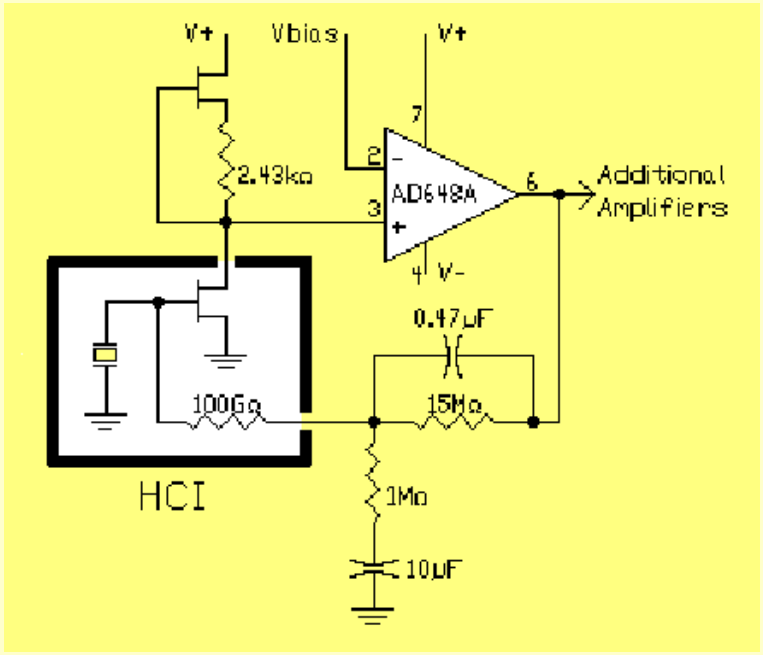
Servo Corp. HCI purchased through AMSAT challenge grant

Infrared detector senses transition between cold space and warm earth.

Ceramic crystal (internal) acts like a charged capacitor

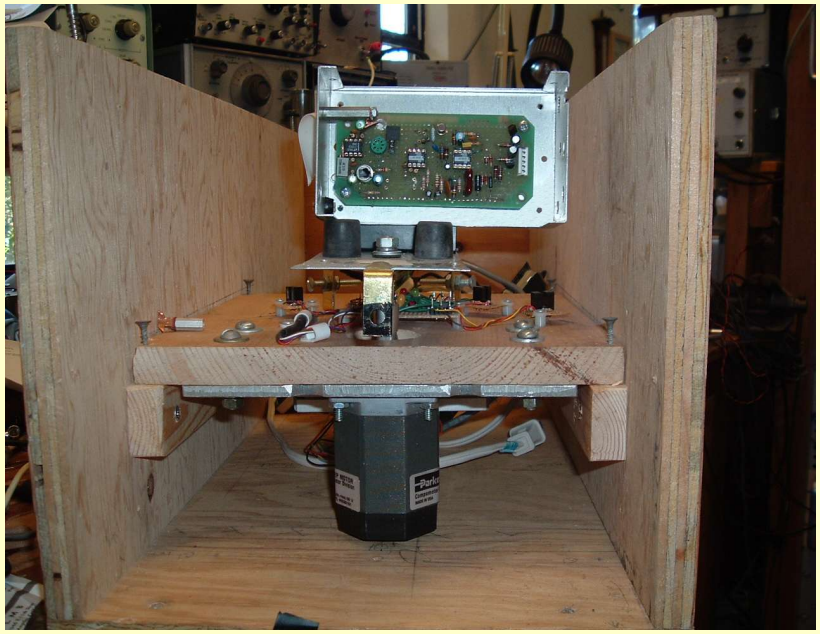
Heat changes capacitance, generating a small voltage change.

EARTH SENSOR ANALOG INTERFACE



1. VERY HIGH IMPEDANCE DETECTOR GENERATES SIGNAL OF A FEW MICROVOLTS
2. LOW LEAKAGE JFET AND 100,000 MEGOHM FEEDBACK RESISTOR LOCATED INSIDE THEHERMETICALLY SEALED SENSOR HOUSING
3. FOLLOWING AMPLIFIERS AC COUPLED-we only need to detect transitions

PRELIMINARY TEST FIXTURE

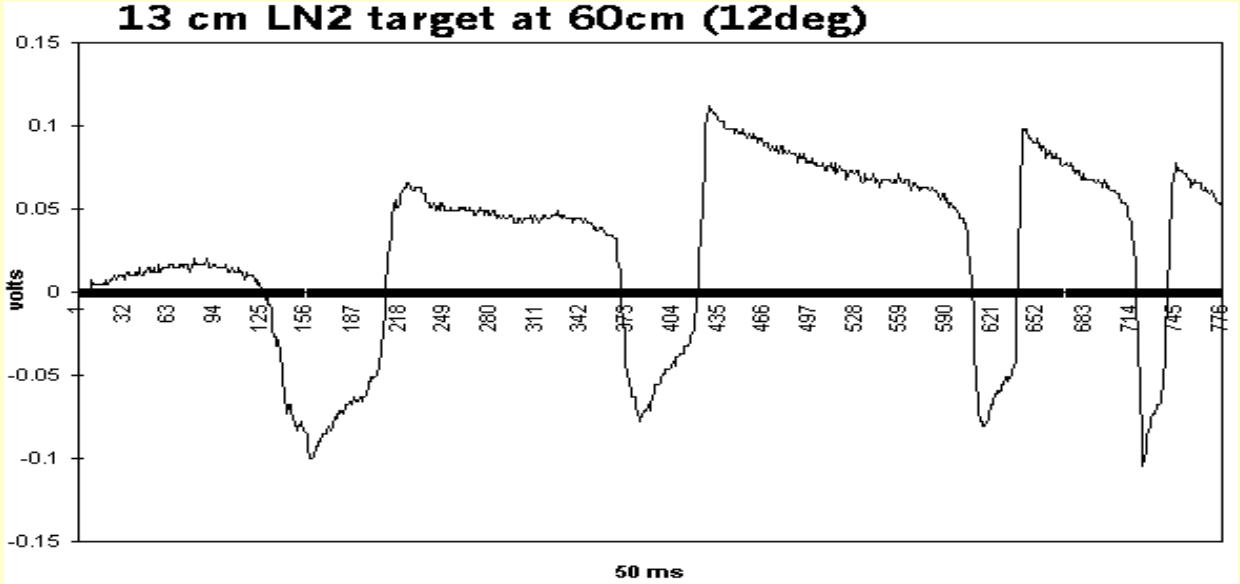


1.Preliminary testing done with motion detector IR sensors.

2.Liquid nitrogen simulates space, room temp. simulates earth

3.Computer controlled stepper motor simulates satellite rotation

CONCEPT TEST DATA (IT WORKS!)



1. Transitions between cold and warm are easily visible
2. LabView software written by team member Mike Miller – WB6TMH
3. Will investigate using motion-detectors in space
4. Data collected on National Instruments data-acquisition card

Eagle CAN bus INTERFACE

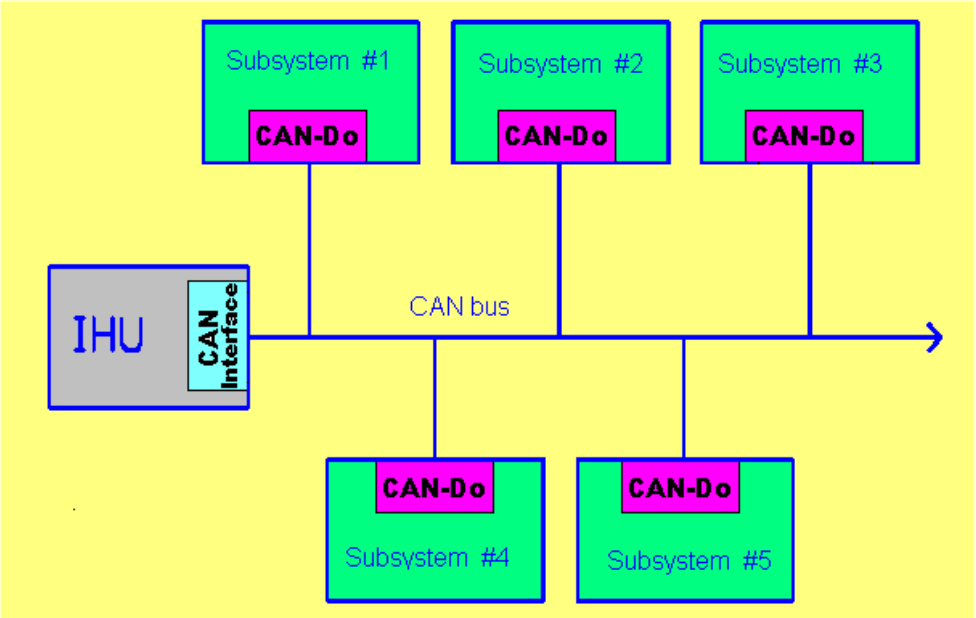
(SENSORS ARE A SUBSYSTEM)

1.CAN is industry standard medium speed serial interface bus

2.Used in automotive and industrial applications

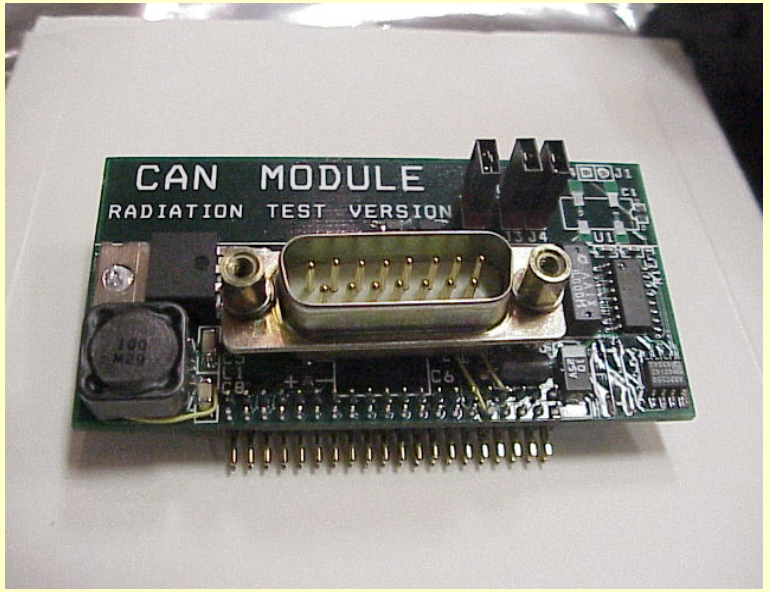
3.First flown on AO-40

4.Interfaces nearly all the Eagle subsystems, including sensors



CAN-Do

1. Standard “CAN-Do” interface module for each subsystem
2. Subsystem analog outputs digitized by A/D converter in module
3. To be used in Eagle, P3E, and other future satellites
4. We plan to use two identical sensor assemblies that each include one staring, slit, and earth sensor and one CAN-Do module.



TESTING OVER THE CAN BUS

Can-232 module

1.CAN-232 **adapter connects serial port on a PC to CAN bus**

2.“UHU” software to simulate IHU written by John Connor NJ0C

3.Allows testing modules the same way they will be used in the space craft

THANK YOU FOR LISTENING

ANY QUESTIONS?